

**WHAT IS CLAIMED IS:**

1. A duo-binary encoder comprising:

a judgment unit for judging whether an odd or even number of '0's exists in data

5 input signals of N channels;

a toggle unit for toggling an output signal of the judgment unit when a number of '0's is even;

an intermediate signal generation unit for determining whether phases of channels other than the N channels are shifted or not, according to an data input signal on  
10 the basis of a predetermined channel of the N channels; and

a phase division unit for dividing data into a first data group having non-shifted phases and a second group of data that require a phase shift, according to an output signal of the intermediate signal generation unit and the data input signal, and outputting the divided first and second data groups.

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2. The duo-binary encoder as claimed in claim 1, wherein the judgment unit includes a plurality of exclusive OR (XOR) gates connected to each other in a pyramid arrangement, so that the judgment unit outputs '0' or '1' when a total number of '0's in data input signals of the N channels is even.

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3. The duo-binary encoder as claimed in claim 1, wherein the toggle unit comprises:

an AND gate for ANDing the output signal of the judgment unit and a clock signal; and

5 a T-FF for toggling an output signal of the AND gate at each rising edge of the output signal of the AND gate.

4. The duo-binary encoder as claimed in claim 1, wherein the intermediate signal generation unit inverts an output signal of the toggle unit to exclusive or (XOR) the data  
10 input signal and the inverted output signal, and then XORs the XORed signal and the data input signal again.

5. The duo-binary encoder as claimed in claim 1, wherein the phase division unit includes  $2N$  number of AND gates so as to AND  $N$  number of intermediate signals, which  
15 are generated by the intermediate signal generation unit, and the  $N$  number of data input signals.

6. A duo-binary encoder comprising:

$N$  number of XOR gates for respectively receiving data signals  $a_{Nn+1}$  to  $a_{Nn+N}$ ;

20  $N$  number of inverters connected to output terminals of the XOR gates;

$N$  number of a first AND gates for respectively ANDing the data signals  $a_{Nn+1}$  to  $a_{Nn+N}$  and output signals of the  $N$  number of XOR gates;

N number of a second AND gates for respectively ANDing the data signals  $a_{Nn+1}$  to  $a_{Nn+N}$  and output signals of the N number of inverters; and

a delayer connected to an output terminal of a nth inverter,

wherein an output signal of the delayer is fed back to the XOR gate to which the  
5 data signal  $a_{Nn+1}$  is input.

7. The duo-binary encoder as claimed in claim 6, wherein the N number of the first AND gates and the N number of the second AND gates divide the data signals  $a_{Nn+1}$  to  $a_{Nn+N}$  into a first signal group having non-shifted phases and a second signal group that  
10 requires a phase shift, respectively.

8. The duo-binary encoder as claimed in claim 6, wherein the N comprises 4.

9. An optical duo-binary transmission apparatus comprising:

15 an encoder for dividing N number of data input signals into a first data group having non-shifted phases and a second data group that require a phase shift, by a parallel processing, and outputting the divided first and second data groups;

a first/second multiplexer for multiplexing the first data group having non-shifted phases and the second data group that require a phase shift, respectively;

20 a coupler for coupling signals respectively multiplexed by the first/second multiplexer so as to output a 3-level signal;

a light source for generating and outputting an optical carrier; and

an optical modulator for modulating the optical carrier into an optical duo-binary signal by the 3-level signal, and outputting the modulated signal.

10. The optical duo-binary transmission apparatus as claimed in claim 9, wherein  
5 the encoder comprises:

a judgment unit for judging whether an odd number or even number of '0's exists  
in N number of data input signals;

a toggle unit for toggling an output signal of the judgment unit when a number of  
'0's is even;

10 an intermediate signal generation unit for determining whether phases of other  
channels are shifted or not on the basis of a predetermined data input signal of the N  
number of data input signals; and

a phase division unit for dividing data into a first data group having non-shifted  
phases and a second group of data that require a phase shift, according to an output signal  
15 of the intermediate signal generation unit and the data input signal, and outputting the  
divided first and second data groups.

11. The optical duo-binary transmission apparatus as claimed in claim 9, further  
comprising a driving amplifier for amplifying the 3-level signal for use as a driving signal  
20 of the optical modulator.

12. A method for duo-binary encoding comprising the steps of:

(a) judging with a judgment unit whether an odd or even number of '0's exists in data input signals of N channels;

(b) toggling an output signal of the judgment unit when a number of '0's is even;

5 (c) determining with an intermediate signal generation unit whether phases of channels other than the N channels are shifted or not, according to an data input signal on the basis of a predetermined channel of the N channels; and

(d) dividing data with a phase division unit into a first data group having non-shifted phases and a second group of data that require a phase shift, according to an output  
10 signal of the intermediate signal generation unit and the data input signal, and outputting the divided first and second data groups.

13. The method according to claim 12, wherein in step (c) the intermediate signal generation unit inverts an output signal of the toggle unit to exclusive or (XOR) the  
15 data input signal and the inverted output signal, and then XORs the XORed signal and the data input signal again.

14. The method according to claim 12, wherein the judgment unit in step (a) includes a plurality of exclusive OR (XOR) gates connected to each other in a pyramid  
20 arrangement, and wherein the judgment unit outputs '0' or '1' when a total number of '0's in data input signals of the N channels is even.

15. The method according to claim 12, wherein the phase division unit in step (d) includes  $2N$  number of AND gates, and wherein the phase division unit exclusive ors (XORs)  $N$  number of intermediate signals, which are generated by the intermediate signal generation unit, and the  $N$  number of data input signals.

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16. A method for providing an optical duo-binary transmission apparatus comprising: the steps of:

(a) dividing  $N$  number of data input signals by an encoder into a first data group having non-shifted phases and a second data group that require a phase shift, by a parallel  
10 processing, and outputting the divided first and second data groups;

(b) multiplexing the first data group having non-shifted phases and the second data group which require a phase shift, respectively by a first/second multiplexer;

(c) coupling signals respectively multiplexed by the first/second multiplexer so as to output a 3-level signal;

15 (d) generating and outputting an optical carrier; and

(e) modulating the optical carrier into an optical duo-binary signal by the 3-level signal from step (c), and outputting the modulated signal.

17. The method according to claim 16, further comprising the step of  
20 amplifying the 3-level signal so as to provide a driving signal to drive of optical modulator.